

AN EVALUATION OF WETLAND FUNCTION AND WATERSHED SIGNIFICANCE OF WETLANDS IN THE BROAD AND NEW RIVER WATERSHEDS

A WETLAND PROTECTION PROJECT FUNDED BY THE ENVIRONMENTAL PROTECTION AGENCY

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1. INTRODUCTION:

Both opponents and proponents of wetland protection support improvement in the regulatory framework for managing freshwater wetlands. Environmental interests often think that the regulatory programs allow excessive loss of ecologically important wetlands. Conversely, interested parties of economic development often find the permitting program time consuming and unpredictable. It is difficult in the coastal area to avoid impacting wetlands. Meanwhile, impacts to freshwater wetlands must be considered, permitted prior to development, and where necessary, mitigated at a ratio decided by members of the regulatory community.

The current freshwater wetland permitting rules apply equally, with minor exceptions, to all wetlands regardless of wetland function or the wetland's role within the surrounding landscape. This approach can result in permits being granted to fill wetlands of high ecological significance or permits being denied on wetlands of relatively low significance, thus hindering job creation or other associated economic growth. Either result is undesirable. On South Carolina's coast, where a high proportion of the land is considered to be wetland and growth is rapid, these wetland issues are continual sources of conflict. Taking these conditions into consideration, it is imperative that improvements be made in the way wetlands are managed.

Many problems associated with the alteration of wetlands are usually not realized until after projects have been completed. The total loss or drastic modification of wetlands can have dramatic implications to a particular location, many times increasing flooding conditions or reducing water quality. The Broad and New River watershed is no exception. Impacts associated with wetland filling and hydrologic alterations include immediate changes in land cover, loss of habitat, higher intensity land use, illegal or accidental filling, and increased runoff from associated and adjacent development.

The problems mentioned above indicate some of the potential complications associated with alterations to wetland systems and the symbiotic relationship wetlands have with other natural systems. Staff at the South Carolina Department of Health and Environmental Control Office of Ocean and Coastal Resource Management (SCDHEC-OCRM) believe that the existing permitting and mitigation framework do not do an adequate job of protecting smaller wetlands that have a high ecological value. Conversely, requirements on degraded wetlands can be too stringent and inflexible. The current regulatory framework provides equal protection to all wetlands, regardless of the history or current function. Additionally, in many cases the vegetative component or habitat value of a wetland is not adequately addressed, resulting in the loss of habitat that is rare or especially sensitive to development. As these sensitive systems are impacted by development, the available uses can become limited, permanently altering the function of the wetland habitat.

SCDHEC-OCRM sought to develop a process that would improve the way wetlands are evaluated for their contribution to a watershed, anticipating that the permitting process could be made more efficient. Developing criteria to evaluate wetland value, contribution, and overall significance at the watershed level will improve the way areas are set aside for future mitigation banks, how organizations prioritize the purchase of development rights, and the way land is identified for outright acquisition. Additionally, as these areas are identified earlier in the planning process, land developers and other participants in the planning process can focus potential impacts away from the most sensitive areas.

The Planning Division of the SCDHEC-OCRM was tasked with developing a methodology and geographic information system (GIS) designed to perform a watershed-based wetland evaluation for the 510,000-acre Broad and New River watershed to meet the objectives described above. In summary, the project's purpose is twofold: 1) to assess wetland function on a watershed basis to improve overall management; 2) to target high priority wetlands for permanent preservation by public agencies or private conservation groups.

The methodology and associated GIS provide wetland permit officers with information and tools to assess a particular wetland's function within a watershed, enhancing the traditional site-level evaluation of wetlands. We anticipate that results from the project will provide decision makers with a better understanding of a specific wetland's role by representing the wetland in the context of the larger watershed.

The report is divided into five sections and follows this general outline:

• Site Characterization

Provides a brief discussion of relevant environmental, economic, and demographic characteristics in the larger watershed.

• Framework For Wetland Management

Describes the existing programs currently operating in South Carolina for the identification, protection, and conservation of wetland areas.

• Southeastern Wetland Modeling Examples

Describes what other states have done with regard to modeling wetland contribution, function, and cumulative value within a watershed.

• Development of the Evaluation Criteria

Discusses the development of the evaluation criteria, data development, and analysis of the data and evaluation criteria used to identify the wetland areas of high significance.

• Recommendations for usage

Provides a discussion of the wetland analysis using the evaluation criteria, and provides recommendations on how to use the results and project products.

Products created from this project include: a method and procedure for evaluating the socio-ecologic value of wetlands within a watershed, an interactive GIS designed for wetland planners and permit officers, recommendations for use of the GIS, an atlas of areas identified as having high socio-ecologic value, and recommendations for improving and streamlining the permit process. Several customized GIS data layers, including identification of rare and sensitive habitats, location of river-buffer corridors, and isolated wetland system connectivity, are also included in the associated data products. Full Federal Geographic Data Committee compliant metadata is included for all data sets used and created within the project's scope.

2. SITE CHARACTERIZATION:

Beaufort and Jasper counties cover approximately 800,000 acres in the lower part of the South Carolina coastal plain. The Broad and New River Drainage Basin covers approximately one third of Beaufort county, one half of Jasper county, and a small piece of Hampton county, and lies within the larger Savannah/Salkehatchie Basin. The Savannah/Salkehatchie Basin originates in the upper portion of the state in the sandhills region and extends through the Lower Coastal Plain and Coastal Zone. Other river systems in this basin include the Ashepoo River, the Coosawhatchie River, the Savannah River, and the Pocotaligo River. The entire Salkehatchie River Basin encompasses 2,127,766 acres of which 35% is forested land, 16% is forested wetland, 15% is agricultural land, 14% is scrub land, 10% is nonforested wetland, 7% is water, 3% is urban land, and 0.4% is barren land. Urban areas include the Town of Hilton Head Island and the City of Beaufort, with smaller municipalities making up a much smaller percentage of urbanized areas.

Only half of the drainage basin is above 42 feet (mean sea level), and at least 20% is regularly flooded by tidally influenced hydrologic systems. The elevation reaches 100 feet in the northwest corner of the study area and is characterized by smaller freshwater streams and isolated freshwater wetlands. There is a variety of habitat and wildlife throughout this portion of the coastal zone. This region is also one of the more sparsely populated areas in the state and contains large parcels of undeveloped property throughout. Figure 2A shows the location of the Broad-New River Project study boundary and its location within the larger Hydrologic Unit 03050208.

This section briefly describes some of the environmental and socio-economic characteristics of the region in order to establish a perspective on the condition of the natural resources and the complexities regarding freshwater wetland resources within the study area.

2.1 RIVERS AND WATERSHEDS

Six watersheds make up the Broad and New River Drainage Basin, receiving drainage from the Coosawhatchie River, Broad River, New River, May River, Whale Branch River, Chechessee River, and Pocotaligo River. All rivers flowing into the study area originate in the Lower Coastal Plain of the state.

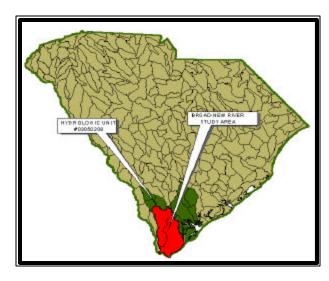


FIGURE 2A: PROJECT LOCATION BROAD AND NEW RIVER WATERSHEDS (THE LINE WITHIN THE RED AREA REPRESENTS THE GENERAL SALTWATER/FRESHWATER INTERFACE)

The majority of these rivers and creeks have good to excellent water quality and support most uses. Several rivers and streams have been nominated as scenic rivers because of their pristine nature. Tidally influenced coastal waterways occupy approximately 70,000 acres of the drainage basin. Under the Clean Water Act, all waters of the state must be given a classification that establishes resource protection goals for each waterway. Most of these waterways are classified as Outstanding Resource Waters (ORW) and Shellfish Harvesting Waters (SFH), and support healthy shellfish and recreational fisheries. These two water quality classifications have the most stringent requirements and limit the activities that can occur on or adjacent to these waterbodies. Other classes in this region include Freshwaters (FW), Tidal Saltwaters (Class SA) and Tidal Saltwaters (Class SB) and have less stringent requirements. Figure 2B shows a generalized water quality map of the Broad and New River Drainage Basin. The areas represented by tan and yellow represent the SFH and ORW classifications respectively. Figure 2C identifies the major creeks, rivers and tributaries within the watershed. One half of the waterways of this watershed are classed SFH or ORW. The others are made up of tidal saltwaters, and freshwater streams.

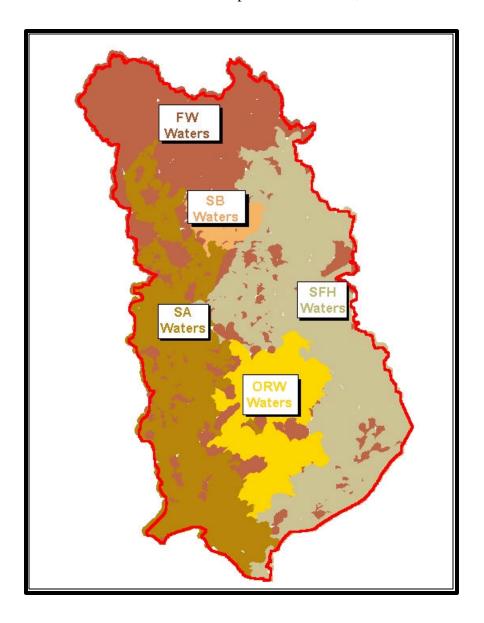


FIGURE 2B: GENERALIZED WATER QUALITY CLASSIFICATIONS OF THE BROAD AND NEW RIVER WATERSHEDS

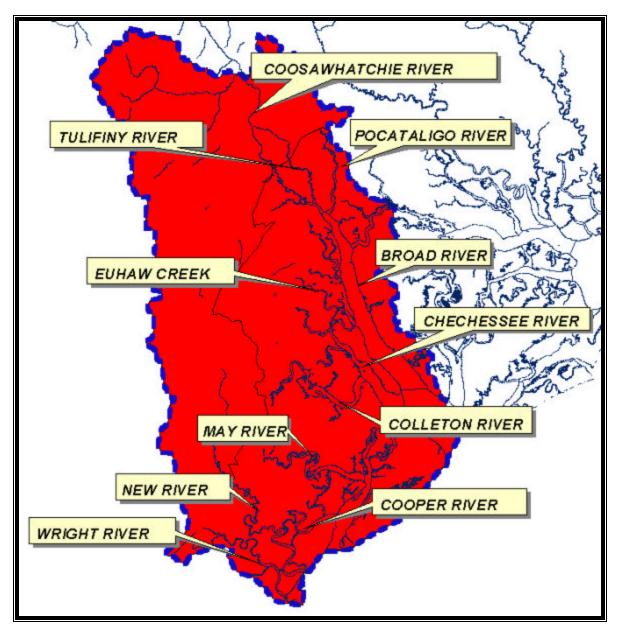


FIGURE 2C: BROAD AND NEW RIVER WATERSHEDS GENERALIZED HYDROGRAPHY

2.2 POPULATION CHANGE

By 1990 there were more than twice as many people living in the Tri-county region, made up of Beaufort, Jasper and Hampton counties, as there had been only forty years earlier. This growth continues at a rapid pace. Table 2A illustrates this population change. Only five years after the 1990 Census, state demographers estimated than an additional 15,000 people had become residents of the region. Much of the growth experienced in the early 1990s was in southern Beaufort County and on Hilton Head Island. However, the fringe areas surrounding Hilton Head

Island, parts of central and northern Beaufort County, and parts of southern Jasper County have been increasing in population as well.

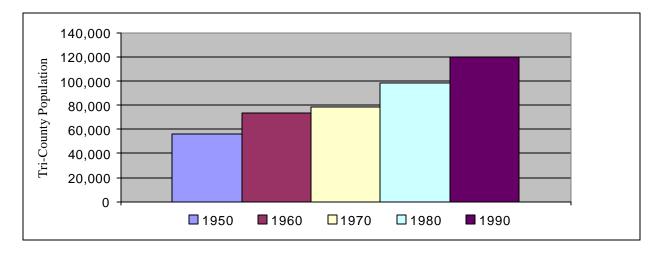


TABLE 2A: TRI-COUNTY POPULATION GROWTH

The largest part of the population growth in the Tri-county region is due to the arrival of new families from areas outside of the Lowcountry. Between 1990 and 1995, census officials estimated that about 40% of the increase in population was due to "natural increase," or more births than deaths. This accounted for approximately 5,100 persons. The rest was due to population gain that resulted from more people choosing to move into the area than choosing to move away, and accounted for a net in-migration of around 8,300 persons.

When the 1990 Census was taken, about half the tri-county population (5 years old or older) had been living in the same house for the past five years. However, almost a third of the people had moved into the area from other states or from overseas.

The changes in population and demographics are having a ripple effect on the region's land use. Much of the region is shifting from an agricultural or fishery based economy to a service economy made up of services in the hospitality, real estate and financial sectors. Other sectors experiencing increasing growth in the region include the health care, assisted living, and transportation sectors. All of this growth and development can consume vast quantities of land and impact regional water quality. Citizens in the Lowcountry recognize the problems associated with the changing landscape and have taken the initiative to better plan for these impacts.

2.3 HABITATS

The habitats of the Broad and New River Drainage Basin consist of a complex, interrelated series of communities ranging from interior pocosins to coastal maritime hammocks and forests. This section briefly describes the area using the traditional Cowardin classification method, used in the National Wetland Inventory Mapping system, and the special habitat mapping project conducted by researchers at The Citadel and the University of Charleston.

2.3.1 The Cowardin Classification System

The area has been classified on National Wetland Inventory maps using the Cowardin (1977) methodology. This classification methodology uses a hierarchical method of identifying environmental characteristics based on a series of modifiers and is used extensively to classify

and document wetlands in the Federal National Wetland Inventory. This data set was a primary source for much of the analysis. A detailed explanation of how this data was used in the analysis is included in Section Five. Additional habitat identification utilizing work completed by the Department of Natural Resources Heritage Trust program improved the way rare and sensitive habitats are identified and mapped.



FIGURE 2D: ESTUARINE COASTAL HABITAT IN BROAD AND NEW RIVER WATERSHED
NEW RIVER LOOKING EAST SOUTHEAST

The Cowardin approach to habitat classification relies on six major categories: marine, estuarine, palustrine, riverine, lacustrine and uplands. These major categories are then modified using a standard set of descriptive modifiers identifying hydrologic and vegetative characteristics such as submerged, frequently flooded, unconsolidated, or evergreen, broad-leaved deciduous, scrubshrub. These modifiers indicate special features regarding the areas and can be used to make generalized judgements about the area. Within the project study area, more than 350 wetland types were identified using the Cowardin classification system.

This project focused on freshwater wetlands, so few if any maritime, or barrier island areas were extensively evaluated. However, because maritime forests are identified as rare and sensitive habitats and are one of the most impacted habitats, they received special consideration where identified. This section highlights some of the qualities of riverine, palustrine and lacustrine systems and provides a brief description of some characteristics common to these wetlands. Figures 2D through 2G show representative examples of the types of environments within the watershed. Below are the major classes used in the Cowardin classification of wetlands with a brief description of each.

♦ General Maritime Ecosystems: areas where land and water have unobstructed access to open ocean, and water regimes and chemistry are determined primarily by tidal action.

- Estuarine Ecosystems: tidal deepwater and wetland areas, usually semi-enclosed by land and having open, partially obstructed or sporadic access to the open ocean.
- Riverine Ecosystems: wetlands and deepwater habitats adjacent to or within a river channel.
- ◆ Palustrine Ecosystems: all nontidal wetlands dominated by trees, shrubs, or persistent emergent vegetation that occur in tidal areas where salinity due to ocean derived salts is below 0.5⁰/₀₀.
- ♦ Lacustrine Ecosystems: all wetland and deepwater habitats that are situated in a topographic depression or dammed river channel.
- ◆ Upland Ecosystems: all nonmaritime areas not classified as wetlands or aquatic systems and characterized by a water table not being at, near or above the land surface for sufficient time each year to promote the formation of hydric soils and the growth of hydrophytes as dominant vegetation.



FIGURE 2E: RIVERINE HABITAT IN BROAD AND NEW RIVER WATERSHED NEW RIVER LOOKING WEST-NORTHWEST

Most of the riverine ecosystems in the watershed are tidally influenced. The freshwater/saltwater interface fluctuates depending on the season and the tide, and much of the water in the project area is brackish. Wide rivers that narrow and become more sinuous farther inland characterize this area. There is abundant wildlife and vegetation along the banks of the rivers, and many rivers have vast freshwater marshes which grade into swamp forests and upland systems.



FIGURE 2F: PALUSTRINE HABITAT IN BROAD AND NEW RIVER WATERSHED ISOLATED SWAMP FOREST

Palustrine wetlands are characterized by standing water much of the time, and include a variety of flora including cypress, pond pine, and other trees adapted to a wetter environment. Palustrine wetlands generally occur on the banks of rivers and can occur in isolated sections of uplands. Many of the isolated palustrine forests act as oases for wildlife and can contain an incredibly diverse range of flora and fauna. These same areas are at jeopardy because of their smaller size and proximity to other activities.



FIGURE 2G: LACUSTRINE HABITAT IN BROAD AND NEW RIVER WATERSHED SHALLOW ISOLATED LAKE

In general lacustrine systems include small ponds, lakes, drowned rice fields not connected to river systems, and large flat areas that flood regularly. These lacustrine systems are essential to many transient birds flying along the coastal migratory routes.



FIGURE 2H: UPLAND HABITAT IN BROAD AND NEW RIVER WATERSHED UPLAND MIXED LOBLOLLY/EVERGREEN FOREST

2.3.2 Identification of Habitats of Critical Concern: The HAB-MAP Project

Vegetated communities were extensively surveyed as a special component of this project to help identify areas where rare or imperiled habitats exist. This information has not existed in map form before and is intended to provide managers and permit officials with an improved ability to make decisions regarding projects adjacent to critical habitats. Researchers at The Citadel and The University of Charleston undertook this effort. Experts in field botany, remote sensing, and GIS were assembled to use a combination of approaches to identify rare and sensitive habitats in the Broad-New River Drainage Basin. The integrated rare and sensitive map in figure 2I was designed to correlate with existing community rarity rankings. The approach and the results of this special project are discussed in more detail in Section Five.

Community rarity rankings have been assembled by the Nature Conservancy in collaboration with the South Carolina Department of Natural Resources, Heritage Trust Program and are based on state and global rarity lists. A full South Carolina vegetated community rarity ranking is included in Appendix D. Figure 2I is a selected list of habitats identified in the study area. Also included is the Cowardin major class, which is an indicator of the habitats landscape position. The map represents a small portion of the study area and is intended to provide a perspective as to the location and distribution of rare and sensitive habitats in the area. It is important to note that some habitat classes have a range of rarity rankings. This reflects the variability of the actual vegetation classes that occur within the drainage basin. The field biologists who performed the reconnaissance work were constantly identifying new, mixed or modified habitats, and were unable to pick a single habitat class to represent those areas. Details on the lessons learned from this part of the project are included in Appendix D, as are the evaluated aerial photographs and associated habitat maps.

HABITAT CLASSES	RARITY	COWARDIN	
	RANKING	CLASSIFICATION	
Longleaf Pine	Uncommon to Rare	Palustrine	
Loblolly Pine	Uncommon	Palustrine	
Pocosin	Uncommon to Rare	Palustrine	
Bay Forest	Uncommon	Palustrine	The state of the s
Depression Meadow	Rare	Palustrine	
Upland Hardwood	Uncommon	Palustrine	
Low Hardwood Flat	Uncommon	Palustrine	
Riparian Swamp Forest	Common	Palustrine	
Isolated Swamp Forest	Uncommon	Palustrine	TO BE WELL TO SEE TO SEE TO SEE
Mixed Hardwood/Pine	Not on List	Upland	150
Maritime Forest	Vulnerable	Upland	May 1
Marsh Hammock	Not on List	Estuarine	
Salt Marsh	Common	Estuarine	
Salt Water	Not Applicable	Estuarine	Common
Fresh Water	Not Applicable	Palustrine	Uncommon Uncommon to Rare
Fresh Water Marsh	Uncommon	Riverine	Rare
Cut-Over	Not on List	Upland	Vulnerable
Field	Not on List	Upland	Uplands
Developed	Not on List	Upland	Water
Spoil	Not on List	Upland	

FIGURE 2I: SELECTED VEGETATED COMMUNITIES IN THE BROAD -NEW RIVER DRAINAGE BASIN

The researchers used materials such as the 1994 National Aerial Photography Program (NAPP) photographs, LandSat TM satellite imagery, and National Wetland Inventory maps to aid in the identification and location of habitats listed on the Nature Conservancy Heritage Trust rarity list. The NAPP photographs provide a high resolution, small-scale photograph of an area and are suitable for intensive digital and manual photo-interpretation. The photography was used as a base map for field operations, as well as a means to help verify field decisions when back at the laboratory.

2.4 SOILS

The soils in the project area vary from moderately well drained to very poorly drained, and have varying degrees of slope; however, no slope is greater than 6% and most slopes are less than 2%. Soils vary from sandy near the coastal margin and barrier islands, to clayey, silty loams in the middle and upper portions of the project area. About 90% of the drainage basin has a high water table, and there is an abundance of streams, inlets, and tidal creeks penetrating the uplands. Additionally, much of the area is not suitable for onsite wastewater disposal systems because of the high water table and saturated soils. The soil survey for the region indicates many of the soil characteristics, and identifies several soil associations with significant upland and wildlife habitat benefits. Figures 2J and Table 2B illustrate the distribution and identify specific characteristics of the soils in the watershed.

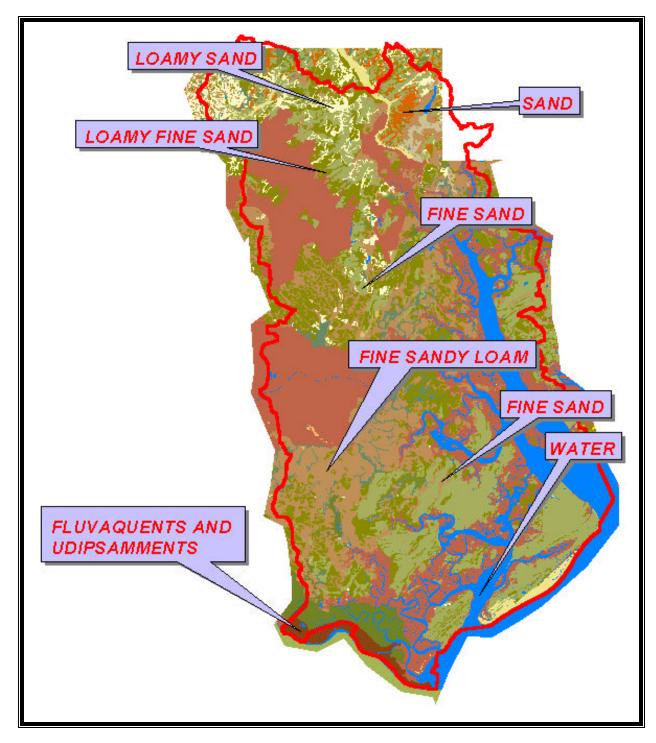


FIGURE 2J: GENERALIZED SOILS MAP IN THE BROAD AND NEW RIVER WATERSHEDS

	G. T.	D
	Soils	Description
	Goldsboro-	Moderately well drained and somewhat poorly drained soils that
ES	Lynchburg-Rains	have a sandy surface layer and loamy subsoil, and poorly drained
PENHOLOWAY AND WICOMICO TERRACES	0 111 011 1	soils that are loamy throughout.
	Ocilla-Chipley-	Somewhat poorly drained and moderately well drained soils that
AY	Blanton	have a thick sandy surface layer and a loamy subsoil, and moderately
Ø ∑	D '11 D '	well drained soils that are sandy throughout.
	Paxville-Rains-	Very poorly drained and poorly drained soils that are loamy
H Q	Lynchburg	throughout, and somewhat poorly drained soils that have a sandy
EN CIC		surface layer and a loamy subsoil.
P		
	Santee	Very poorly drained soils that have a loamy surface layer and clayey
		subsoils.
	Buncombe	Excessively drained soils that are sandy throughout.
	Argent-Okatee	Poorly drained and somewhat poorly drained soils that have a loamy
		surface layer and a clayey subsoil.
	Bladen-Coosaw-	Poorly drained and somewhat poorly drained soils that have a loamy
5-3	Wahee	surface layer and clayey subsoils, and somewhat poorly drained soils
CE		that have a thick sandy surface layer and a loamy subsoil.
\mathbb{R}^{A}	Wando-	Excessively drained, moderately well drained, and somewhat poorly
ER	Seabrook-Seewee	drained soils that are sandy throughout.
ΙC	Coosaw- Williman-	Somewhat poorly drained and poorly drained soils that have a thick
CC	Ridgeland	sandy surface layer and a loamy subsoil, and somewhat poorly
PAMLICO TERRACE	_	drained soils that are sandy throughout.
PAJ	Fripp-Baratari	Excessively drained and poorly drained soils that are sandy
	The City of	throughout.
	Tawcaw-Chastain	Somewhat poorly drained soils that are clayey throughout, and
SN SE		poorly drained soils that have a loamy surface layer and a clayey
E.A.	Bohicket-Capers-	subsoil.
DPJ R.S.	Handsboro	Very poorly drained mineral and organic soils that are flooded daily
ΘŽ	Trandsboro	or occasionally by saltwater, and adjacent upstream areas that are
		flooded occasionally by freshwater.
SOILS IN FLOODPLAINS AND TIDAL MARSHES		
ŠΑ		

TABLE 2B: SOIL DESCRIPTIONS FOR SOILS IN THE BROAD -NEW RIVER DRAINAGE BASIN

2.5 SUMMARY

In closing, the Broad and New River Drainage Basin contains a diverse range of habitats, soils and wetlands, and is experiencing a very high rate of change due to economic and societal forces. These changes are having and will continue to have a noticeable impact on natural areas within the basin. The purpose of this project was to utilize the best available information regarding the environmental and socio-ecologic characteristics to quantify the value and contribution of wetlands to the watershed, help identify ways the planning process for wetlands could be improved, and identify those areas within the drainage basin deserving the highest priority for preservation, conservation, or restoration.

3. FRAMEWORK FOR WETLAND MANAGEMENT IN THE BROAD AND NEW RIVER WATERSHED

Impacts to freshwater wetlands must be identified and permitted prior to development. It is difficult in the coastal area to avoid impacting wetlands. This project is based on the assumption that the regulatory framework for managing freshwater wetlands can be improved. Environmental interests often feel that the existing regulations allow excessive loss of ecologically important wetlands. Conversely, economic development proponents often find the framework time consuming and inflexible.

The current freshwater wetland permitting rules apply equally to all wetlands, with little regard for wetland function in the context of the surrounding landscape. This approach can result in permits being granted to fill wetlands of high ecological significance or permits being denied to wetlands of relatively low significance. Either result is undesirable. Many projects that involve the alteration of wetlands develop into situations where the loss of vital wetlands is necessary in order to bring a beneficial economic activity to the region. On South Carolina's coast, where a high proportion of the landscape is wetland and growth is rapid, improving wetland management and the wetland permitting process is of critical if the state is to maintain the special qualities wetland resources afford Lowcountry life.

The State of South Carolina does, however, have a network of wetland planning and permitting organizations devoted to improving the planning and permitting process. Several of these programs are identified and briefly described in the following section to provide the reader with a perspective of the current situation. Ways to improve planning and permitting coordination are also mentioned. The programs described in this section document the way the state is identifying, mapping, and managing freshwater and tidal wetlands. This discussion is not intended to be comprehensive; rather, this section will highlight some areas for future integration into the wetland planning process at a watershed scale.

3.1 FEDERAL 404 PERMITS AND THE WETLAND CERTIFICATION PROCESS

Wetlands are defined by the US Army Corps of Engineers (USACOE) and the EPA as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (USACOE regulation 33 CFR 328.3 and EPA regulation 40 CFR 230.3). In South Carolina, protection for wetlands is derived from state laws and regulations passed to comply with Federal Clean Water Act (CWA) Section 401 requirements and the policies of the South Carolina Coastal Zone Management Act (SCCZMA). The 1972 South Carolina Pollution Control Act established legislation for the state to conduct wetland protection practices. The CWA Section 401 requires that states certify that water quality is protected and will not be substantially impacted by all projects that require an USACOE dredge or fill permit and is administered by the SCDHEC, Bureau of Water (BOW). In the eight county coastal zone of South Carolina, the SCCZMA requires certification of state and federal permits with impacts to freshwater wetlands, and requires permits for activities impacting saltwater wetlands. These activities include projects that discharge or dredge materials from rivers, streams, and other wetlands.

The SCDHEC-BOW administers these regulations in parts of the state outside of the coastal zone. Within the coastal zone SCDHEC-OCRM is the responsible management agency as

established by the SCCZMA. Additionally, SCDHEC-OCRM has certification responsibility for USACOE Federal 404 permits in freshwater wetlands within the coastal zone. SCDHEC-OCRM also has direct permit authority over any and all actions that occur in the "critical area" or those tidal salt marshes along the South Carolina coast.

State and federal legislation establishes the framework for wetland regulation in South Carolina. However, limitations exist including a dependency on wetland size in determining potential impacts. For example, isolated or non-connected wetlands are not evaluated the same as larger wetlands. Regulators realize that focusing on wetland size to determine potential impacts results in the alteration of highly significant isolated wetlands and the denial of permits to wetlands that are of little regional significance.

3.2 SCDHEC-OCRM WETLAND MASTER PLANNING

In an effort to provide developers with an incentive to approach wetland management in a more comprehensive fashion and to provide some flexibility when developing adjacent to wetlands, the SCDHEC-OCRM uses a wetland master-planning concept. The concept is simple and effective and has greatly reduced wetland conflicts in the coastal zone by providing flexibility to the strict rule of no wetland alterations. Wetland master planning is applied to all projects undergoing consistency certification in the coastal zone and other projects requiring other state and federal permits. Traditionally, wetlands are delineated prior to the issuance of permits. Once delineated, the SCDHEC-OCRM works with the permit applicant and other parties to evaluate wetland impacts and, where required, alter the application so the project can be approved. The wetland master planning policies are stated in Chapter III of the SCDHEC-OCRM's Coastal Zone Management Program document (summarized below) and ultimately govern the outcome of the project review.

If a pre-development wetland master plan is prepared for a project, identifying all wetlands, drainage patterns and conceptual development, isolated freshwater wetlands of one (1) acre or less in total size may be incorporated into the project development without restrictions provided:

- 1. The wetlands contain no endangered species or critical habitat;
- 2. The wetland losses are adequately mitigated.

The SCDHEC-OCRM must certify the wetland master plan. Input is received from other reviewing agencies, which include the SC Department of Natural Resources, the U.S. Fish and Wildlife Service, and the Environmental Protection Agency. In the absence of a wetland master plan, the Resource Policies, Chapter III, Coastal Zone Management Program, is utilized to guide project certification. Types of wetland impacts which may require mitigation include disposal of fill material, dredging or excavation of wetlands, clearing of vegetated wetlands, and ditching of wetlands.

The avoidance of wetlands is preferable to mitigation. Mitigation of wetland impacts is considered only after all policies of the Coastal Zone Management Program document and the SCCZMA have been addressed and the policies are found to allow an alteration to wetlands (page 12, SC CZM Program Refinements, 1993). A mitigation plan must then be submitted by the applicant and approved by the SCDHEC-OCRM.

3.3 LOWCOUNTRY COUNCIL OF GOVERNMENTS (LCOG)

The primary purpose of LCOG's Planning Department is to provide professional planning services for Beaufort, Jasper, Hampton and Colleton counties. For the past two years the agency focused on preparing comprehensive plans for local governments in the region under the Local Government Comprehensive Planning Enabling Act of 1994. This act required all local governments who have development regulations to adopt new comprehensive plans by May 3, 1999. To date, comprehensive plans for Jasper County and for four municipalities in the project area are completed, and the agency is nearing the completion of plans for Hampton County and four additional towns. The Beaufort County has also completed a comprehensive plan.

Besides comprehensive planning, the LCOG Planning Department also provides a variety of other planning services to members of the council, particularly those local governments without full-time planning staffs. These services include writing or updating zoning and other land development ordinances. The agency also works with individual planning commissions to help review specific development proposals, and to provide research on specific topics. The LCOG also acts as a hub for the creation and coordination of data and information regarding the long-range regional change of an area. With the current requirements to include a natural resources element in local and county comprehensive plans, the LCOG could act as a partner in planning large-scale projects which impact coastal and freshwater wetlands.

In addition to working with local governments, LCOG is concerned with planning issues on a regional scale. The area-wide 208 Water Quality Management Plan and the Regional Solid Waste Program are both administered by LCOG. A regional approach to planning for infrastructure improvements, particularly water and sewer is also being evaluated under a grant from the University of South Carolina. Later this year, the agency will begin work on developing a plan for a system of recreational trails throughout the region. There are currently no formal mechanisms for evaluating and measuring change in coastal wetlands at LCOG; however, the opportunity for improved communication and coordination at the preliminary planning stage exists.

3.4 MITIGATION BANKING REVIEW TEAM WORKING GUIDELINES FOR SITING PRESERVATION BANKS

The Mitigation Banking Review Team (MBRT) provides a coordinated framework for the development and maintenance of freshwater mitigation banks. This program was established in the early 1990s to help meet the goals and objectives of the Clean Water Act and improve the conservation of wetland resources in South Carolina. The MBRT operates under a Memorandum of Agreement (MOA) approved by all parties involved in wetland regulation.

The MBRT is made up of representatives from a number of state and federal resource and environmental agencies. This committee has periodic reviews of the procedures and policies established in the agreement, and approves all elements of the signed MOAs when mitigation banks are established in the state.

The MBRT maintains that offsite mitigation is not preferred and should be considered only after all onsite alternatives have been exhausted, and that having access to a mitigation bank does not negate the requirements of conducting an alternatives analysis to determine if the project's impacts have been minimized or avoided. However, onsite mitigation is not always feasible. In

those cases, the permitting entities approve or deny mitigation requests and determine the required ratios to satisfy permit requirements.

Mitigation banks are approved offsite if the creation or restoration of wetlands is shown to have a more significant regional benefit than any onsite alternatives. Connecting isolated wetlands along the banks of a river system and the purchase of an entire island with regional significance are two such examples. The location of mitigation banks is based on a number of measurable criteria including opportunities for restoration or enhancement, cost, size, relative ecological value, adjacent land uses, presence of contaminants, and intensity of human interactions.

South Carolina has been divided into five service units for purposes of MBRT activities. Service units act as the management jurisdiction used by the MBRT for operation of the program, and are based on the major river systems of the state. The study area of this project falls within service unit four, the Coastal Plain, and unit five, the Lower Coastal Plain. Mitigation banks are generally required to be located within the same service unit as the wetlands being impacted; however, exceptions can be made if an ecological benefit can be shown.

3.5 SOUTH CAROLINA DNR HERITAGE TRUST

The SCDNR Heritage Trust Program, the first such program in the nation was created in 1976. The program's stated mission is to preserve those natural features and cultural remains that are quickly disappearing as the state's population increases in size. The agency is responsible for inventorying, evaluating, preserving and protecting the places considered to be the most outstanding representatives of our state's natural and cultural heritage.

The Heritage Trust Program, part of the Wildlife Diversity Section of DNR, is funded by State appropriations, the Endangered Wildlife Fund, the Endangered Species License Plate and by a small portion of revenue collected from the real estate documentary stamps tax. The income is deposited into the Heritage Land Trust Fund and used for acquisition of significant natural and cultural areas.

Heritage Trust staff, in concert with related agencies and personnel, search the state for rare plants, animals, birds, archaeological sites, and other significant features of South Carolina's heritage. The goal is to permanently protect the best examples of these features through a system of heritage preserves established for the benefit of present and future generations.

The program is overseen by the Heritage Trust Advisory Board, which was created by law to make recommendations concerning protection of land under the Heritage Trust. No such protection can be initiated without the approval of the Advisory Board. Their expertise and broad representation assure that time and funds are devoted to the most urgent and worthy projects.

3.6 SUMMARY

Each program described in this section has the potential to improve wetland management and planning within the state. Good long-term working relationships exist between most of the natural resource agencies mentioned. Mechanisms, such as monthly interagency meetings, are already well established and have led to improved coordination among resource agencies. Interagency meetings are attended by representatives from state, federal and local governments and permit applicants, and projects of interest and significance are discussed. Those existing

relationships and processes provide a good base from which to improve wetland management. The next section describes how other states have evaluated the contribution and value of wetlands, and provides example for SCDHEC-OCRM to consider for improving wetland planning in the coastal zone.

4. SOUTHEASTERN WETLAND MODELING EXAMPLES

The development of an evaluation criteria for the wetlands of the Broad and New River drainage basin was enhanced by several regional examples covering parts of the Southeastern United States. These models served as examples to the technical advisory committee in part because they involved similar types of projects covering similar coastal ecosystems. The development team had the added advantage in that parts of the models described in this section utilized standard national datasets that could easily be incorporated into South Carolina's coastal environment. These datasets which are discussed in the next section of the report allowed for immediate utilization of existing prioritization schemes. Several of the models described in this section have been cited nationally as examples for evaluating the contribution and significance of coastal wetlands within a watershed.

Additionally the examples described in this section provided the development team with multiple ways to visualize the outcomes. A key component of the Broad and New River Watershed Wetland Evaluation Criteria was to develop a visualization and reporting scheme that would help the permit officer and planner focus attention on especially sensitive and valuable wetlands within a watershed.

Below are brief discussions of the regional wetland modeling examples used in the development of the criteria for the Broad and New River Watershed study.

4.1 NC-CREWS: NORTH CAROLINA REGIONAL EVALUATION OF WETLAND SIGNIFICANCE

As a result of shortcomings in the protection of non-tidal wetlands by the North Carolina Coastal Zone Management Program, the Division of Coastal Management (DCM) developed an improvement strategy for non-tidal wetland protection and management. A key element of this strategy was the development of a Wetlands Conservation Plan for the coastal area. A first step in establishing the Wetlands Conservation Plan was the identification and mapping of wetlands within the region. The DCM recognized weaknesses of the 404 permitting program in that individual permits evaluated only wetland functions within a specific site, rather than the role the wetland plays in the larger region. The need for identifying wetlands with a higher ecological significance was critical for improving the process. The DCM determined the best way to do this was through an integrated GIS approach, but in order to rate wetland value within the watershed, a scientifically sound protocol needed to be established.

The primary objective of the protocol was to produce information about the relative importance of wetlands that would be useful for planning and overall management of the state's coastal wetland resources. This tool would provide the ability to predict the functional significance of a wetland rather than provide them with regulatory decision making abilities. The agency recognized that if planners could identify potential 404 permitting problems in advance, then there could be increased permitting efficiency by focusing developments away from areas identified as ecological significant. The model was not to eliminate site visits, or wetland delineations, rather, the model would have the ability to predict what a site visit might determine and identify "red flags" prior to permit application or project review.

The model integrates many components of the Hydrogeomorphic Classification (HGM) system used by many wetland planners for evaluating wetland contribution and significance, and relies on the relationship a wetland function has with its surrounding landscape. This model uses 39

parameters to determine a wetland functional assessment within a watershed. The model has been applied in Cateret County, and results have been evaluated for incorporation into other parts of the state. The outcome of the model is a generated map layer built around the scale of USGS topoquads, and provides a regional demonstration of wetlands of higher ecological significance. This map is easily incorporated into a GIS and can be made available in either digital or hard copy form. The NC-CREWS model is currently being investigated for use in South Carolina for possible assistance in the 401-certification process as well.

4.2 ROOKERY BAY

The Rookery Bay Advanced Identification of Wetlands project was a federally funded project that covered the Rookery Bay habitats in Collier County, Florida. The project was conducted during the early 1990s and was completed in 1996. The project was developed to help environmental planners in the region evaluate the suitability of areas for the placement of dredge fill material. Project staff stress, however, that this project was designed to be a preliminary planning tool. The Executive Summary states that the primary objective of the project was to provide information about the relative function of a wetland within the context of the project area.

In addition to a number of recommendations, the project also developed a protocol for the selection of wetland functions, a series of wetland functional parameters, and an "Advanced Identification of Wetlands Functional Assessment" model. This model served as the framework for wetland modeling efforts in the Broad and New River Watersheds. Whereas the NC-CREWS project evaluated the relationships of 39 parameters, the Rookery Bay project took a simplified approach evaluating 13 parameters within the region. These parameters, which looked at the proximity of resources, soil type, wetland type, and habitat type, became the foundation from which the parameters of the Broad-New River project were built.

As an end result of the Rookery Bay project, the area was classified into two wetland categories: Category I wetlands, where the preservation of chemical, physical and biological integrity was critical; and Category II wetlands where Army Corp of Engineers and other permitting entities requirements were to be satisfactorily met prior to permit issuance. Category II wetlands were also considered areas within which to focus potential mitigation alternatives. It was noted that where wetlands supporting rare and sensitive habitats were identified, these areas became a higher candidate for preservation.

5. DEVELOPING A WETLAND PLANNING TOOL

In order to develop a wetland planning tool for permit officers and land use planners of the region, a wetland evaluation criteria and a technique to apply the criteria within the watershed was needed. However, it was not necessary to start this criteria development from scratch. It was also not necessary to develop a wetland functional assessment model, as was the case in several of the previously described projects. These existing models, developed in similar southeastern ecosystems, provided the agency with an excellent base from which to make improvements and refinements. This section describes the process for developing the planning tool.

Visualizing the socio-ecologic value of a site's wetlands was important in order to evaluate potential negative or positive impacts. The parameters used in the other regional wetland models were critically evaluated by the Technical Advisory Committee (TAC) and were used to identify those characteristics wetland planners needed to analyze in order to determine a site's value. The TAC is discussed in the next section in detail. The regional examples mentioned earlier provided examples for visualizing the outcomes, demonstrated display schemes and provided ways to discuss the results. Table 5A provides a list containing the criteria parameters chosen for inclusion in the evaluation criteria. All categories were used in the Broad and New River evaluation criteria, and a detailed explanation of individual parameters is included in Appendix A. Items checked are parameters included in the regional modeling examples described in the previous section.

Paran	neters	NC- CREWS	Rookery Bay
1.	Non-Point Source Protection	✓	
2.	Watershed Position	✓.	
3.	Proximity to Outstanding Resource Waters	✓	✓
4.	Wetland Buffering		✓
5.	Shoreline Anchoring		✓
6.	Storm Surge Protection		~
7.	Water Storage in Wetlands	✓.	
8.	Water Storage in Soils	✓	
9.	Velocity Attenuation	✓	✓
10.	System Integrity (Hydrologic Alterations)		
11.	Sediment and Toxicant Removal	✓	✓
12.	Nutrient Removal in Wetlands	✓	✓
13.	Nutrient Removal in Soils	✓	•
14.	Habitat Provision	✓	✓
15.	Habitat Diversity		✓
16.	Proximity to Streets	✓	
17.	Proximity to Protected Areas		

FIGURE 5A: WETLAND EVALUATION CRITERIA CATEGORIES

The primary objective of this phase of the project was to develop a method to evaluate the functional characteristics of wetlands in the context of the surrounding landscape and watershed. The resulting criterion integrates disparate data into a consolidated regional index representing wetland contribution, function, and significance over the entire watershed.

To accurately evaluate the wetlands across the watershed, and include socio-ecologic components that do not directly relate to wetlands, a new technique was required. A detailed

discussion of the development of the technique is provided in section 5.4 and 5.5, but it is important to note that for the integration of parameters mentioned above and included in Appendix A, a cellular analysis of the study area was utilized. A one-acre sampling grid containing over 500,000 cells was created for the entire study area. Individual parameters representing environmental, ecological, and other functions, values, and conditions were evaluated and scored according to the criteria in Appendix A. Tabulating the parameters identified in Table 5.1 summarized each cell. This produced an index value score representing a combination of socio-ecologic characteristics. The index value score became the foundation for identifying wetlands of highest socio-ecologic value, and was used to generate maps and data analysis regarding areas of concentrated high value wetlands. Both wetlands and uplands were treated equally and started with an equal base value. Open water areas and coastal salt marshes were later removed from the evaluation because of the protection already provided from existing regulations.

Some elements of the analysis technique followed the previously mentioned models. However, this technique differs in that a grid analysis was utilized instead of a polygonal analysis. These previously described models evaluated functional combinations utilizing National Wetland Inventory polygonal boundaries, provided by the USFWS. This, while being spatially accurate, relied heavily on boundaries that may have changed since the datasets were created. A grid approach allowed for a somewhat more generalized approach to a regional evaluation of site conditions by blurring the distinction between what may or may not be wetland. As the end result of the project was to create a wetland planning tool and not negate the importance of field evaluations of actual site conditions by professionally trained wetland ecologists, the TAC felt this technique was appropriate. Consistent with other regional evaluation techniques the TAC also felt that it was necessary to examine wetlands independently from uplands, but to include an analysis of upland systems as they relate to the parameters used in the criteria. This analysis of uplands was anticipated to help identify possible upland corridors for inclusion into potential mitigation areas.

5.1 TECHNICAL ADVISORY COMMITTEE (TAC)

The TAC was assembled early in the project and was used as the mechanism and platform to review the technical and scientific issues that arose throughout the project. A primary responsibility of the committee was to review the data needs and develop the interface for evaluating the results of the watershed evaluation.

Members of the committee provided a variety of experiences in the fields of information management, data development, materials presentation, and display design, and provided a forum to review ideas at regular intervals. The committee was made up of professionals from local, regional, and state governments, and the private sector. The committee met quarterly to evaluate data development progress, systems design, and interface development, as well as evaluate analysis results.

The committee was also tasked with assisting in the review of the evaluation criteria. As mentioned earlier in this report, the project development team had the benefit of learning from the experiences of other southeastern states wetland evaluation projects. The majority of committee members had first hand experience in the use of geographic information systems, and provided representation of the future potential users of the data and management information system. The committee was consulted on a regular schedule to review components of the management information system and the final output deliverables provided in the appendices.

5.2 DATA AND HARDWARE CONSTRAINTS

The Broad-New River Watershed is fortunate to have an abundance of high-quality GIS data covering the entire study area. Much of the data used in the analysis came from the South Carolina Department of Natural Resources Geographic Information System Data Clearinghouse and can be accessed from the web site located at this address http://water.dnr.state.sc.us/water/nrima/gisdata/. The GIS data used for analysis in this project is listed in Table 5B. It is important to note that most of the data in the project is accurate to approximately one acre, reinforcing the use of a one acre sampling grid over the entire study basin.

Data layers used in the project include NRCS Soils, National Wetland Inventory, DNR derived hydrography, TIGER transportation networks, rare and sensitive habitats, protected land, and Beaufort and Jasper County parcels. Data was collected from the appropriate sources and merged into watershed scale maps at the 1:24,000 scale. These data sets became the foundation for the GIS part of the evaluation technique mentioned earlier and described in detail in Appendix C. Several datasets had been improved from other efforts, and provided this project with valuable additional information. These datasets included hydrography complete with stream order, stream flow conditions, water classifications, and stream name, soils data including slope, type, hydrologic group, and name, and National Wetland Inventory with a land use/land cover analysis.

The National Wetlands Inventory (NWI) became the most heavily used base dataset for the evaluation of wetland areas. This dataset provided a foundation for many of the water quality and hydrology parameters in the evaluation procedure. In addition the spatial resolution of the data provided an adequate scale to use in the evaluation as well.

Soil maps were extensively utilized to help better identify areas with hydric soils and areas with greater water retention possibilities. These data sets while being somewhat general in accuracy, provide a suitable base from which planners can begin to formulate ideas about site suitability. The SCDHEC-Bureau of Water also developed additional attributes for area hydrography and provided attributes identifying stream order, stream type, and water quality classification.

Additional data sets were developed specifically for this project. The Lowcountry Council of Governments developed a parcel map for properties over 500 acres in size for Jasper County. This dataset included attributes on ownership, use, and status. The parcel map for Jasper County was combined with a parcel layer representing parcels over 50 acres for Beaufort County, providing the TAC with the ability to identify property owners owning land identified as having a very high value. Originally, Jasper County had no digital data representing parcel boundaries. Since much of the county is made up of parcels larger than 500 acres, the development of these data sets provided the regional partners as well as the TAC with a new data set for inclusion in future projects.

All data layers can be queried sequentially using avenue-programmed scripts within the ARCVIEW GIS to highlight the parameters of interest. A high, medium, and low (2,1,0) score characterizes the individual parameters and represents the socio-ecological value for sites within the watershed. For example, sites identified within or intersected by wetlands adjacent to permanent surface water or within 1000 feet of permanent surface water were rated the highest and given a score of two for the *Non-Point Source Protection* parameter. Appendix A provides a complete description of the individual parameters with rationales and scores.

DATA LAYERS INTENDED PURPOSE Soils

Indicates soil conditions, suitability, slope and other

site specific characteristics

Land Parcels Identifies land activity, ownership, impervious

> surface estimates (in Beaufort County) Identifies important habitat areas using TNC

(from NWI base map) classification

Hydrography Indicates stream order, stream flow, drainage

(as modified by DHEC-BOW)

Transportation Identifies streets and highways

NWI Land Cover Indicates land cover type, habitat impacts

NWI Vegetation Indicates habitat type using Cowardin Classification

System

TABLE 5B: DATA LAYERS USED IN THE EVALUATION PROCEDURE

5.3 GAPS IN DATA AVAILABILITY

Upon evaluation of existing data sets for the region, it was recognized that to achieve a comprehensive evaluation, additional data development was needed.

5.3.1 Parcel data development

TNC/Heritage Trust Rare Habitat

As discussed previously, parcel data did not exist for Jasper County in any digital form, therefore a contract was initiated with the Lowcountry Council of Governments to develop a data layer containing parcel boundaries and associated information for all parcels larger than 500 acres. This data was later merged with the data provided by Beaufort County. The parcel data provided the development team with the ability to identify the land owners in areas that scored very high according to the evaluation criteria. Having an inventory of the largest landowners within the county had the added advantage of providing analysts with a measurable area for comparison and quantification of "high value" areas.

5.3.2 Identification of Rare and Sensitive Habitats

An underlying precept of this project was to identify areas that had a high potential for habitat usage and areas of rare, vulnerable or imperiled habitats in the coastal region. The National Wetland Inventory maps or other mapping data sets do not adequately represent this information; therefore it was necessary to provide a method for identifying these areas. Many of these areas, such as Saw Palmetto Flatwoods, are classified as uplands in the NWI mapping products, and therefore not included in the current review and permitting process by agency officials. Many of these habitats border wetlands however, and provide important linkages between systems.

A contract was initiated with the College of Charleston's Office of Applied Technology, and the Citadel's Department of Biology to develop a data layer that represented rare and sensitive habitats in the region. A detailed description of this project is included in Appendix D. Table 5C highlights the Nature Conservancy/Heritage Trust program's community rarity list. This list changes periodically so the data set generated for the use in this project would need to be updated as needed in the future. The items in red are the habitats that were found in the study sites by researchers.

As this component of the project was limited by university and agency restrictions, and time and budgeting constraints, the researchers attempted to use an integration of modern remote sensing technology and time tested field efforts. The researchers used a combination of experts in the fields of ecology and biology with recent high-resolution aerial photography to identify rare and sensitive habitats. It was anticipated that the habitats listed in Table 5C could be found both in the field and using aerial photography, and could be reliably mapped. Researchers hypothesized that habitats would generate different color signatures in the photography and be identifiable using algorithms derived from remote sensing software. Combining field verification efforts with the remote analysis would offer a repeatable method for identification of individual vegetated communities and provide environmental managers with a much improved information source.

Unfortunately, the time and budgeting constraints mentioned earlier did not allow for the whole watershed to be evaluated using this approach. The researchers were asked to pick eleven photographs that would be a representative sample of the watershed. This covered approximately four USGS topoquads within the watershed. The researchers were also asked to pick areas in both the completely fresh systems as well as the saline estuarine systems in the lower portions of the watershed. However, because the fieldwork was done from a moving vehicle, the researchers also needed to pick areas with roadways and available access. When the researchers needed to access private lands, efforts were made to gain approval by local members of the TAC. Generous participation by corporate landowners and partners made this possible.

After the field work and photo-interpretation components were completed, the interpreted images were then correlated to a current LANDSAT Thematic Mapper (TM) satellite image covering the entire project area, by participants from the Office of Applied Technology from the University of Charleston. It was anticipated that the LANDSAT TM scene would provide an adequate representation of habitats in the study area and would correlate well to the habitats identified by the Citadel researchers, providing an exceptional current snapshot of rare and sensitive habitats in the region. This data could then be utilized into the regional GIS for representing habitat and rarity within the watershed.

TNC Heritage Trust/ Community Rarity	Tidal Freshwater Marsh
Ranking	High Pocosin
- Cantaing	Bay Forest
Imperiled	Pocosin
Forested Canebrake	Pond Pine Woodland
Southern Appalachian Bog	Natural Levee
Peatland Canebrake	Acidic Cliff
Hillside Herb Bog	Intertidal Beach
Wet Marl Forest	Pine Flatwoods
	Bald Cypress Swamp
Vulnerable	Non-Riverine
Piedmont Seepage Forest Interdune Pond	Wet Hardwood Forest
	Pond Cypress Pond
Beech-Magnolia Hammock	Streamhead Pocosin
Piedmont Seepage	Common
Rare	Bald Cypress
Upland Depression Swamp	Tupelo Gum Swamp
Limestone Sink	Bottomland Hardwoods
Seepage Pocosin	Non-Alluvial Swamp Forest
Atlantic White Cedar Swamp	Atlantic Coastal Plain
Swale Pocosin	Depression Meadow
Depression Meadow	Black Willow
Pine Savanna	Riverfront Forest
Pond Cypress Savanna	Brackish Marsh
<u>Uncommon</u>	Estuarine Intertidal Mud Flat
Barrier Island Pond Complex	Estuarine Intertidal Sand Flat
Interior Freshwater Marsh	Intertidal Mud/Sand Flat
Longleaf Pine Savanna	Nonriverine Swamp Forest
High Elevation Seep	Salt Marsh
Swamp Tupelo Pond	Small Stream Forest
Tidal Bald Cypress -	Upland Bog
Tupelo Gum Swamp	Opialia Dog

FIGURE 5C: TNC HERITAGE TRUST VEGETATED COMMUNITIES RARITY RANKING FOR SOUTH CAROLINA

As often occurs with research, the photography and satellite imagery did not provide results as expected. The spectral signatures in the NAPP photography and the LANDSAT TM scene did not provide an adequate distribution to provide the identification of individual vegetated communities. Where the researchers anticipated that twenty to twenty-five classes of vegetation would be identified in the photography, only thirteen classes were, and several of these were not definitive. The LANDSAT TM scene only provided seven classes and was not capable of differentiating between oaks and pines, a critical distinction. The data generated from these efforts is included in the regional GIS in Appendix C, however, the data was not used in the existing form in the analysis. The lessons learned from the researchers at The Citadel and The University of Charleston provided the opportunity to take an alternative approach to identifying rare and sensitive habitats. Again, the regional models described in Section 4 provided a similar methodology on which to base the rare and sensitive habitat mapping.

The researchers from the Citadel and University of Charleston spent a great deal of time identifying habitats in the field, and documented this information on small scale reprints of the NAPP photography. This information was used to reclassify NWI wetlands from the Cowardin style description into a description highlighting a vegetation type identified in Table 5C. This approach was also used in two of the regional modeling examples discussed earlier, and proved to be very effective in identifying areas with rare, imperiled or vulnerable habitats. The hypothesis was that a Cowardin style classification can be used to identify vegetated communities, and fieldwork would verify the habitats identified. This alternative approach would support the designation of areas with rare, imperiled, or vulnerable habitats across the watershed. The NWI dataset was then amended to include attributes representing vegetated

community and rarity ranking. A detailed list of habitats using the Cowardin style classification method with the TNC/Heritage Trust categories is included in Appendix D.

5.3.3 Demographic data and population dynamics

The data readily accessible by the TAC was sufficient for the environmental characteristics, but much of the demographic data was not. A second contract was initiated with the College of Charleston's Office of Applied Technology to help develop the necessary demographic data for use in the environmental criteria. Data desired from this component included: 1990 population, 2010 projected population, and subdivision development plans. However, because of the distribution of the rural population in most of Beaufort and Jasper County and the lack of consistent data sets throughout the watershed, the collected information did not provide any information that could be applied at the evaluation scale. This information became ancillary material and was not used in the evaluation criteria.

5.4 THE EVALUATION CRITERIA

Parameters chosen to evaluate the relative value of the lands in the study area consider such factors as non-point source pollution, velocity attenuation, water storage, erosion control, habitat support, habitat diversity, watershed position, nutrient removal, and societal stress and the relationships they have with the other parameters. The parameters were chosen to describe parts of the wetland system that have significant environmental benefits when maintained in a natural or undisturbed state. Data layers were chosen that represented areas within the watershed as accurately and currently as possible. The datasets used included soils, National Wetland Inventory, hydrography, transportation networks, habitat, protected land, parcels, population change, and land cover.

In order for a parameter to be used as a query, the parameter had to meet several conditions. First, the parameter had to be equally appropriate across the entire watershed. Second, the data had to be consistent across the watershed. Third, the GIS must be capable of interpreting the parameter properly, and last, the parameter must represent a measurable characteristic. Many iterations of the parameters and their rationales were evaluated for use in the model and an example is provided in figure 5D. However, the evaluation criterion is infinitely adjustable to meet future goals and include features identified as important in future projects. A detailed description of the parameters and the scoring scheme is included in Appendix A.

The queries used in the evaluation utilize the spatial relationship environmental characteristics have with each other. For example, the following query identifies and scores sites with nonpoint source pollution removal functions beneficial to maintaining or improving water quality;

- 1. Sites that are identified as wetlands in the National Wetland Inventory are selected.
- 2. Next, all selected wetlands adjacent to hydrographic bodies identified as permanent surface water are selected.
- 3. Those wetlands adjacent to the permanent surface water are selected and given a value of two, because wetlands and areas adjacent to permanent surface water perform a valuable function with regard to removing non-point source pollution and deserve a higher score with regard to this parameter.
- 4. There are three variables to query within each parameter, and the process listed above is repeated to evaluate each variable. For example, the second variable identifies wetlands adjacent to waterbodies identified as intermittent streams. These wetlands receive a score of one. This process is then repeated for each of the seventeen parameters in the evaluation and included in Figure 5A and Appendix A.

Proximity to Water Bodies Non-point Source Functions

- Is the site within 1000 feet of permanent or intermittent surface water?
 - Rationale: Proximity to surface water is an indicator of the likelihood that polluted runoff entering the wetland would otherwise enter surface water. Wetlands close to permanent water are rated the highest
- 2 Sites within wetlands adjacent to permanent surface water or within 1000 feet of permanent surface water
- 1 Sites within wetlands adjacent to intermittent surface water or within 1000 feet of intermittent surface water
- 0 All other Sites

FIGURE 5D: SAMPLE QUERY FROM THE EVALUATION CRITERIA

5.5 HOW THE GIS WETLAND EVALUATION MODEL WORKS

The wetland evaluation model was developed using ARCVIEW 3.1 and all data included in the GIS product is not dependent on specialized extensions. The GIS and a detailed operations manual are provided in Appendix C, and this section briefly explains basic functionality.

To perform a cellular analysis in ARCVIEW, a "pseudo-grid" was created using a custom script that places a point, representing the center of a hypothetical one acre grid cell, within every acre of the watershed study boundary. The points were later converted to polygons representing one-acre sites over the entire watershed. This created a data layer of more than 590,000 "cells" each with total programmatic control. Having access to an individual attribute within an individual cell greatly improves the functionality of the system by providing users more flexibility as well as more descriptive power during analysis.

The pseudo-grid became the control layer and individual attributes were added, acting as placeholders for the parameters identified previously. Each attribute was numeric and used a scale from 0-2 representing varying degrees of functionality or importance from lowest to highest respectively.

An added benefit of the using the pseudo-grid approach and the use of shapefile themes was the capability to perform *Theme on Theme Selections* in ARCVIEW, allowing for an easy, more visual approach to identifying sites with higher socio-ecologic characteristics. Another benefit of this approach was using a spatial resolution of one acre. As a one acre spatial resolution was the average of the data sets, this cell size worked well for aggregating boundaries from multiple disparate data sets. For example, hydrography data is used as polylines, whereas wetland data comes from polygons. The cellular approach combined the wetland boundaries with other boundaries into individual one acre cells, ultimately creating a multi-tiered overlay fully utilizing the McHargian principal critical in identifying where, why, and how valuable areas are.

6. RESULTS AND RECOMMENDATIONS

he results of the evaluation criteria indicate several areas of concentrated "high value" sites. The term high value is applied to all one acre sites with a summary index value greater than fourteen. This accounts for approximately fifty-six percent of the watershed; however, when the open water/river systems are removed from the calculations the coverage drops to approximately thirty-seven percent of the watershed. Figure 6A shows the statistical distribution of the index value score from the evaluation criteria. The numbers indicate the scores of the summarized attributes described in the previous section. Statistically, the values ranged from a score of zero to a maximum score of twenty-nine, with a mean value of eleven. The bi-modal distribution has two distinct zones with a standard deviation of 5.92 indicating that there are concentrated areas of high value sites and areas with lower aggregate scores. Few sites fall in the middle.

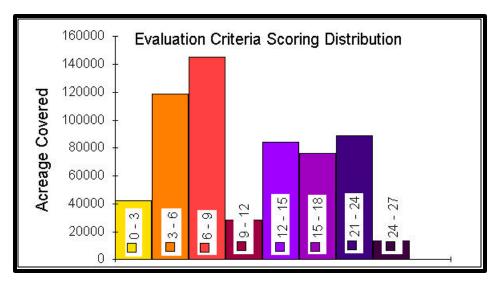


FIGURE 6A: DISTRIBUTION OF EVALUATION CRITERIA INDEX VALUES

The map in figure 6B shows a definite bias towards the coastal estuarine wetland systems and heavily favors emergent wetlands. The map also highlights some inland systems along river corridors. In some cases because of the one acre sampling grid, the distinction between upland and wetland systems becomes blurred. Evaluating these areas more closely, one might conclude that some upland connectivity exists, therefore connecting isolated sites. The criteria can be used to identify possible linkages between isolated or separated wetland systems in the northern and central part of the watershed. These sites were selected in part through the generous buffers applied to the water quality and non-point source pollution components in the criteria. This buffer distance can be adjusted depending on the interest of the individual conducting the evaluation.

Figure 6B, shows the concentration of wetlands on a square mile basis. Areas in dark green show the areas where the index score was greater than 18. Areas in light green show values greater than 14 but less than or equal to 18. The results clearly indicate a concentration of high value sites along the banks of the Broad River, Coosawhatchie River, Wright River and New River, with other river systems also showing very high concentrations as well. The analysis was performed using a ratio derived from the wetland index value score to the number of occurrences per square mile. This algorithm establishes the concentration of sites and allows the user to

identify areas within the study area that deserve the highest initial focus on conservation or preservation of wetlands.

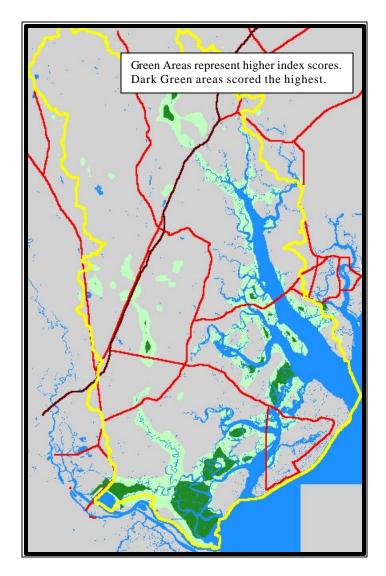


FIGURE 6B: CONCENTRATION OF WETLANDS WITH HIGHEST INDEX VALUE SCORES

6.1 Recommendations

he areas shown in dark green in Figure 6B have the highest concentration of high value wetlands per square mile, indicating areas of concentrated environmental significance or hotspots. These hotspots are deserving of a higher level of protection for the continued functional and ecological benefits of the overall system.

Based on the analysis of the data by the evaluation criteria described herein, SCDHEC-OCRM proposes the following recommendations be adopted by the governmental entities of the state and within the planning boundary.

1. Concentrated "high value" sites should be designated Geographic Areas of Particular Concern by SCDHEC-OCRM, and made subject to the review procedures associated with other GAPCs.

- 2. For mitigation purposes, the wetland/upland connection should be considered, calculated separately, and maintained for continued function of the wetland system.
- 3. Isolated wetlands with rare, vulnerable or imperiled habitats as designated by the Nature Conservancy/Heritage Trust community rarity ranking should be designated as GAPCs and identified as priority protection, conservation, or acquisition sites.
- 4. Beaufort County, Jasper County, DHEC, DNR, The Nature Conservancy, and the Lowcountry Open Land Trust should work together in identifying these sites and develop appropriate strategies for priority protection, conservation, or acquisition.
- 5. Developments should seek to reduce wetland impacts and not infringe on more than 30% of project sites occupied by high value sites.
- 6. Sites identified as "concentrated high value sites" (Index score >14/mile²) according to the evaluation criteria should be made high priority areas for the siting of permanent mitigation banks by the Mitigation Banking Review Team.
- 7. The Mitigation Banking Review Team should include a measure of habitat sensitivity in the siting of mitigation banks.
- 8. The SCDHEC-OCRM will work with local and regional governments to conserve sensitive and rare habitats in a coordinated and organized framework, starting with areas that have been deemed "high value" by the evaluation criteria
- 9. SCDHEC-OCRM should revise its project submittal requirements to require a wetland habitat survey in areas identified as having rare or sensitive habitats, or have been deemed "high value" sites by the evaluation criteria.
- 10. Wherever possible, developers and the state will avoid the filling or diking of wetlands for road construction or other uses that have contiguous rare or sensitive habitat designation or have scored an index value greater than 20.
- 11. SCDHEC-OCRM should use the evaluation methodology, the watershed evaluation atlas, and the associated GIS included in the project final report to aid in establishing mitigation requirements for projects within the Broad and New River Watershed.
- 12. The baseline evaluation index should be updated as new data and information become available.
- 13. SCDHEC-OCRM should maintain a GIS data layer of preserved wetlands and buffers on projects over 10 acres in size. This can be implemented by requiring digital wetland maps for projects over 10 acres in size as part of the permit application.
- 14. More research should be conducted to improve methodologies for identifying habitats from aerial photography and satellite images to improve the identification of areas under stress from encroachments.
- 15. Governments within watersheds should work to coordinate the collection of data to better identify cross-jurisdictional trends regarding population change, environmental change, and other characteristics.

APPENDIX A: PARAMETERS OF THE EVALUATION CRITERIA

SURFACE WATER TYPE

- 1 IS THE SITE WITHIN 1000 FEET OF PERMANENT OR INTERMITTENT SURFACE WATER?
- Rationale: Proximity to surface water is an indicator of the likelihood that polluted runoff entering the wetland would otherwise enter surface water. Wetlands close to permanent water are rated the highest
- 2 Sites within wetlands adjacent to permanent surface water or within 1000 feet of permanent surface water
- 1 Sites within wetlands adjacent to intermittent surface water or within 1000 feet of intermittent surface water
- 0 All other sites

PROXIMITY TO HIGH ORDER STREAMS

- 2. IS THE SITE LOCATED WITHIN 1000 FEET OF HIGH ORDER STREAMS?
- Rationale: The higher a wetland is in a watershed, the greater the potential effect of NPS removal on overall watershed water quality.
- 2 Sites within 1000 feet of High Order Streams
- 1 Sites within 1000 feet of Middle Order Streams
- 0 All Other Sites

PROXIMITY TO ORW WATERS

- 3 IS THE SITE WITHIN 1000 FEET OF A WATERBODY CLASSIFIED AS ORW, SFH OR FW?
- Rationale: Wetlands and sites adjacent to ORW waters deserve a higher degree of protection because of the combination of benefits these areas provide.
- 2 Sites within 1000 feet of ORW Waters
- 1 Sites within 1000 feet of SFH and FW Waters
- 0 All Other Sites

EROSION CONTROL

- 4 DOES THE SITE RESIDE WITHIN WETLANDS CLASSIFIED AS EMERGENT WETLANDS CONTIGUOUS TO THE SHORELINE (NWI COWARDIN SYSTEM)?
- Rationale: The plants of this type bind the soil with their root systems and are important in anchoring the shoreline to prevent coastal erosion, especially during storm events. Emergent Wetlands have the highest shoreline anchoring capacity.
- 2 Sites identified as NWI wetlands identified as Emergent wetlands adjacent to permanent surface water
- 1 Sites identified as NWI wetlands identified as emergent wetlands not adjacent to permanent surface water and non-emergent wetlands (i.e. Scrub-Shrub, Forested)
- 0 Sites identified as Uplands

SYSTEM INTEGRITY/HYDROLOGIC ALTERATIONS

- IS THE SITE A WETLAND AND INTERSECTED BY DITCHES, CANALS, OR OTHER HYDROLOGICAL ALTERATIONS? (All NWI wetland classes with special modifiers referring to hydrologic alterations.)
- Rationale: Hydrological alterations, such as ditches and canals, decrease water retention time in adjacent wetlands, and increase the flow of water into open water systems. Wetlands without hydrological alterations are more likely to significantly alter flood flows, and are rated higher.
- 2 Sites identified as Wetlands with no Hydrologic Alterations
- 1 Sites identified as Wetlands with Hydrologic Alterations
- 0 Sites identified as Uplands

UPSTREAM WETLAND BUFFERING

- 6. DOES THE SITE RESIDE WITHIN RIVERINE WETLANDS, WET PRAIRIES OR MARSHES, CYPRESS HEADS OR STANDS, HYDRIC PINE FLATWOODS, MIXED SWAMPS, OR SHRUB SWAMPS (NWI RIVERINE, LACUSTRINE, OR PALUSTRINE WETLANDS)?
- Rationale: Riverine, sheetflow, and depressional wetlands in the middle and upper parts of the watershed play an important role in improving water quality. These wetlands retain sediments, nutrients, and toxicants in runoff, thereby preventing contaminant overload to the lower end of the system (the estuary).
- 2 Site identified as the wetlands listed above
- 0 Site identified as outside of wetlands listed above

VELOCITY ATTENUATION

- 7. DOES THE SITE RESIDE WITHIN NON-TIDAL AND SATURATED OR SEASONALLY FLOODED WETLANDS (NWI water regimes B or C)?
- Rationale: Saturated and seasonally flooded wetlands are more likely to alter flood flows than are wetlands that are flooded most of the time, such as tidal systems.
- 2 Sites identified as NWI wetlands identified as saturated, and non-tidal
- 1 Sites identified as NWI wetlands identified as seasonally flooded and non-tidal
- 0 All other sites

WATER STORAGE CAPACITY OF WETLANDS

- 8 DOES THE SITE RESIDE WITHIN WITH WETLANDS VEGETATED WITH TREES, SHRUBS, OR EMERGENTS (NWI CLASSES FO, SS, EM)?
- Rationale: These types of wetlands are more capable of altering flood flows because of greater frictional resistance caused by their stems and trunks, than are wetlands classified as aquatic bed.
- 2 Sites identified as NWI Emergents
- 1 Sites identified as NWI Scrub/Shrub or Forested
- 0 Sites identified as Uplands

WATER STORAGE CAPACITY OF SOILS

9 DOES THE SITE RESIDE WITHIN SOILS IDENTIFIED AS HYDROLOGIC GROUPS A, B AND A/D OR C AND B/D?

Rationale: Soils in these hydrologic groups are identified as having features which allow for longer retainment of surface and groundwater.

- 2 Sites identified as NRCS Soils identified in Hydrologic Groups A, B, and A/D
- 1 Sites identified as NRCS Soils identified in Hydrologic Groups C and B/D
- 0 Sites identified as NRCS Soils identified in Hydrologic Group D

NUTIRIENT REMOVAL CAPACITY OF WETLANDS

- 10. DOES THE SITE RESIDE WITHIN SATURATED (B), SEASONALLY FLOODED (C), SEMI-PERMANENTLY FLOODED (F), UNKNOWN (U), IRREGULARLY FLOODED (P), SEASONAL-TIDAL (R), IRREGULARLY EXPOSED (M), OR REGULARLY FLOODED (N) WETLANDS?
- Rationale: Wetlands with alternating wet and dry conditions in the middle and upper parts of the watershed play an important role in improving water quality. Wetlands higher up in the watershed determine the biogeochemical state of the entire watershed. In addition, these wetlands retain sediments, nutrients, and toxicants in runoff, thereby preventing contaminant overload to the lower end of the system (the estuary).
- 2 Sites identified as NWI Saturated, Seasonally Flooded, or Semi-permanently Flooded wetlands
- 1 Sites identified as NWI Irregularly Flooded, Seasonal Tidal Flooding, Irregularly Exposed, or Regularly Flooded
- 0 Sites identified as Uplands

NUTIRIENT REMOVAL CAPACITY OF SOILS

- 11. DOES THE SITE RESIDE WITHIN SOILS IDENTIFIED AS HISTOSOLS OR FREQUENTLY FLOODED MINERAL SOILS WITH HIGH CLAY AND ORGANIC MATTER CONTENT, OR INFREQUENTLY FLOODED MINERAL SOILS WITH HIGH CLAY AND ORGANIC MATTER?
- Rationale: These soils have higher nutrient removal capabilities than soils with low clay and organic contents.
- 2 High: Sites identified as Histosols or Frequently Flooded mineral soils with high clay and organic matter content
- 1 Medium: Sites identified as Infrequently flooded mineral soils with high clay and organic matter
- 0 Low: Sites identified as Infrequently flooded mineral soils with low clay and organic matter

SEDIMENT AND TOXICANT REMOVAL

- 12. DOES THE SITE RESIDE WITHIN AREAS VEGETATED WITH EMERGENTS, SHRUBS, AND OR TREES (corresponding to the NWI classes of emergents (em), scrub-shrub (ss), and /or forested (fo)?
- Rationale: Emergent, scrub-shrub, and forested wetlands are important in the maintenance of water quality and provide more favorable conditions for removal of sediments/toxicants due to the greater frictional resistance to water flow from rooted stems than those vegetated with floating as most toxicants are attached to soils particles rather than dissolved in the water column.
- 2 Sites identified as NWI Emergent Wetlands
- 1 Sites identified as NWI Scrub/Shrub or Forested Wetlands
- 0 Sites identified as Uplands

VEGETATION TYPE

- 13 DOES THE SITE RESIDE IN AREAS IDENTIFIED AS WETLANDS WITH FORESTED COVER OR IS ON AN ESTUARINE FRINGE? (NWI class E2FO, E2SS or NWI class PFO)
- Rationale: Forested cover wetlands support a diverse group of wildlife species, including nesting and roosting wading birds, amphibians and habitat specialists such as the red-cockaded woodpecker.
- 2 Sites that are wetlands and identified as E2FO, E2SS, or PFO
- 1 All other wetlands
- 0 All other sites

HABITAT RARITY

- 14 DOES THE SITE RESIDE WITHIN AREAS IDENTIFIED AS A HABITAT OF CRITICAL CONCERN?
- Most listed species in decline are as a result of habitat impact and fragmentation. Areas of high biodiversity can be documented by consideration of areas where large numbers of wildlife species and rare animals and plant communities occur. Indicator or umbrella species can be utilized to assess diversity.
- 2 Sites identified as Habitats listed as Imperiled, Vulnerable, or Rare according to Heritage Trust/TNC ranking
- 1 Sites identified as Habitats listed as Uncommon according to Heritage Trust/TNC ranking
- 0 Sites identified as Habitats listed as Common according to Heritage Trust/TNC ranking

HABITAT DIVERSITY

- 15 DOES THE SITE RESIDE WITHIN PINELAND OR PINE/CYPRESS WETLAND WITH HYDRIC SOILS?
- This habitat provides both wetland and upland functions, thereby allowing for a greater diversity of plant species that support diverse invertebrate and vertebrate animal species.
- 2 Sites that are wetlands and identified in the HAB-MAP project as pineland, pine /cypress, in hydric soils
- 1 All other sites that are identified as wetlands
- 0 All other upland sites

PROXIMITY TO PROTECTED LANDS

- 16 IS THE SITE WITHIN A DISTANCE (CLOSE PROXIMITY) OF PROTECTED AREAS?
- Sites that fall within close proximity to areas designated as protected or under conservation easements already provide a level of potential protection, however, many parts of the areas surrounding these protected lands are uplands and not considered in wetland permitting. Natural buffers should remain within close proximity to these protected areas, and uplands and wetlands should be included within this procedure.
- 3 Sites identified within than 3200 feet from Wildlife Management Areas/ Heritage Trust Sites.
- 2 Sites identified within than 1600 feet from State Parks/Conservation Easements.
- 1 Sites identified within than 800 feet from State Parks/Conservation Easements.
- 0 Sites not in close proximity to identified protected areas.

PROXIMITY TO STREETS AND HIGHWAYS

- 17. DOES SITE FALL WITHIN 300 FEET OF MAJOR ROADWAYS?
- Sites directly adjacent to roadways, while being important areas, may not provide the most cost efficient use of limited mitigation/conservation resources. It may be more in the agency's interest to identify areas further away from major roadways for the use of agency mitigation resources.
- 2 Sites identified greater than 300 feet from roads.
- 0 Sites identified within 300 feet from roads.



APPENDIX C: WETLAND EVALUATION GIS AND USERS GUIDE

APPENDIX D: CONTRACT FINAL REPORTS AND SUPPORTING MATERIAL

After determining the boundary for the OCRM project LCOG set about researching properties that would be included in this area. This included research at the assessor's office in Jasper County to determine the best method of data transfer. Jasper County does not have up to date cadastral maps or digital data. Paper companies own some of the largest properties and we were able to obtain from them digital files of their properties. When this portion of the project was completed, LCOG then ran copies of the tax maps from Jasper County and pieced them together to begin the digitizing process. This was most time consuming as there was little to nothing to work with, i.e. coordinates. Dan Morgan, Beaufort County GIS Director, participated in this phase to a great extent helping to determine coordinates using USGS topo maps. Many hours were spent with this process. There was also another major problem: determining matching coordinate points from the USGS topoquads to the tax maps; points that would be clearly shown on the topoquads rarely matched anything on the tax maps. When picking the points there was also the problem of the size of the digitizing table. Therefore, a decision had to be made as to the size of the properties that LCOG would supply. LCOG asked that only properties of 500 acres up be included from Jasper County. Those properties were completed, to include the owner information and parcel identifiers.

CITADEL CONTRACT NUMBER EQ-8-530

Mapping of Habitats of Critical Concern

As a component of the Broad and New River Project, our group investigated the feasibility of using an RGB based image analysis program, Dimple, to identify significant vegetative communities in the Broad/New study area. We selected 11 1994 National Aerial Photography Program (NAPP) 1:40,000 photos as representative of the 43 that give total coverage of the study area. These 11 color infrared aerial photos were digitized and stored on CDs. 36" x 36" laminated prints were made for use in ground mapping and supervised classification. Teams led by Porcher and Everett went to each of the areas covered by NAPPs and identified examples of the vegetative communities, indicating their location on the laminated NAPPs with permanent markers. The names of communities encountered were listed and where possible correlated with the SC Nature Conservancy Community Nomenclature system.

The field verified NAPPs were used in a supervised computer classification technique (Maximum Likelihood) that attempted to extend the identification of known examples of communities to unknown examples based on their pixel composition similarity. The outcome of this procedure led to several conclusions:

- 1. More communities are recognizable on the ground than can be recognized by the computer analysis.
- 2. Because the RGB signatures of some communities are similar, the identification process often ends in either/or statements. For example, the community is either loblolly, longleaf pine or maritime forest.
- 3. Variations in NAPP photos, even on a single photo, make area to area application of training sets unworkable in some cases.

Having found this limitation with the Dimple analysis, we recommended to SCDHEC that an extension of our work be done using Adobe Photoshop to "patch" errors in the computer classification. This work produced images that are accurate, more detailed in the identification of communities and easy to use. The Photoshop corrected images were returned to Dimple to be reregistered and saved to a CD for incorporation into the project GIS product.

Listed below are the products we have appended to this report:

- 1. A list of plant communities found in the study area.
- 2. Color print copies of the Dimple classifications with legends.
- 3. Color print copies of Photoshop corrected Dimple classifications of study area NAPPs.
- 4. A color-coded master legend of community types.
- 5. A key that relates our community designations to the SC Nature Conservancy system where possible.
- 6. A CD with Dimple classifications and Photoshop corrections of Dimple classifications (registered in UTM coordinates) without attached legends.
- 7. A CD with the original UTM registered and rectified NAPPs of the study area.

UNIVERSITY OF CHARLESTON CONTRACT NUMBER EQ-8-117

UNIVERSITY OF CHARLESTON CONTRACT NUMBER OC-98-001

Mapping of Habitats of Critical Concern

The Broad and New River Project is a wetlands protection and restoration program funded by the Environmental Protection Agency and administered by the S.C. Office of Coastal Resource Management. It is developing a program for watershed-based wetland management and for conserving high-priority wetlands. The location of key habitats or natural systems is one factor in the Project conservation/acquisition strategy.

However, the cost of area-wide field inspections by trained observers is very expensive and ground-level surveys are also limited to areas where property-owners are willing to grant access. This work was undertaken to investigate the potential for using remote sensing to provide reliable, cost effective inventories of the plant communities and ecological systems that are found over large areas.

College of Charleston Office of Applied Technology collaborated with field biologists at the Citadel to develop a cost-effective method for detailed ecological characterization of the coastal zone using satellite imagery. The Citadel team worked with large format aerial photography to provide the locations of known plant communities which were then used to "ground truth" satellite imagery of the region. The goal was to produce value-added GIS products to serve as advanced planning tools for OCRM, other State agencies responsible for managing natural resources, and local governments.

A Landsat Thematic Mapper multi-spectral imager (30 Meter pixels, 7 bands) from March 1998 was geo-rectified and registered to Universal Traverse Mercator (UTM) Zone 17). Initially, an attempt was made to merge the 30m image with the 1996 Spot panchromatic image (10 m pixel, 1 band) to increase spatial resolution. However, we found that the spatial resampling altered the spectral properties of the image. This reduced the accuracy of the classification so we decided to work with imagery having the original 30m spatial resolution.

An Isodata unsupervised (ERDAS) classification of the TM image generated 100 individual GIS classes from the spectral data. These classes were recoded into 30 habitat classes. These were, in turn, recoded into a final aggregate number of seven classes, which closely matched the field collected ground control polygons designated by the Citadel field team. A National Wetland Inventory (NWI) water boundary was overlayed on this image to delineate the land/water boundary. This border was then searched landward to create a 90m (3 pixel) buffer from the shoreline. This buffer represents the immediate watershed of the adjacent water mass and thus, any areas of possible maritime and riparian forest within the buffer might be considered potential conservation hotspots. The projection of the final thematic image was resampled to State Planes NAD83 5201 for DHEC in-house use.

The lack of precise ground control data prevented us from navigating to the exact location of "ground truth" data. This reduced the accuracy and precision of the classification because it was impossible to identify the patches within the "ground truth" polygons. These patches were visible as distinct classes but without more precise information on their location, we could not verify the classification. Greater accuracy and precision of this habitat classification might have been possible if the field "ground truth" data had been spatially located using high-precision Global Positioning System (GPS) fixes. This might have helped to resolve the within patch micro patterns into estimates of true habitat patchiness.

If accurate positioning is used with this type of collection, the smaller habitat patches might have been discernible and a supervised product of 12-15 classes might have been possible. This would yield a more precise delineation in some of the hotspot areas, and show species cohabitation in wetland areas that would allow biologists and permit experts the ability to draw conclusions more easily from a computer screen review of the imagery. Instead, these smaller habitat classes were aggregated into the larger habitat patch of the surrounding area.

A second approach to delineating potential ecological hotspots was undertaken was taken because we felt that there may be alternative methods of producing a value-added image. Two indices were combined in a synthetic model to produce a mapping of water/land separation and plant communities that develop in soils with high moisture content (possible wetlands or ecological equivalent). This model is based on the ratio of TM bands 2 to 5 which is sensitive to the land/water boundary because the upwelling radiance from water in the spectral range of TM band 5 is near zero. It is also sensitive to the moisture content of chlorophyll containing leaves. The analysis produced a value-added GIS image that contains nine classes: open water, salt marsh, intertidal, and six classes corresponding to terrestrial habitats graded from wet to dry. Urban areas and other dry habitats, including roads and high reflectivity substrates fall into the dry end of the scale. Habitats containing wetland forests and communities on saturated soils fall into the wet end of the spectrum. The distribution of these classes closely matched the distribution of soil types and National Wetland Inventory maps. Thus, this technique shows promise for providing information to planners and permitting agencies that can be used to assess the potential suitability of land for development.

In summary, it does seem possible to produce a general habitat mapping that is of potential utility to community planners and resource managers. The broad habitat distributions can be shown. In conjunction with available GIS products such as National Wetland Inventory maps, a value-added mapping can point to critical habitats that lie within functional watershed boundaries. Resource managers can then carry out directed field sampling to inspect areas that may lie with the bounds of prospective permits or conservation areas.

COMMUNITY RARITY RANKINGS FROM HERITAGE TRUST

Imperiled		
mper	Forested Canebrake	G1Q
	Southern Appalachian Bog	G1
	Peatland Canebrake	G1
	Hillside Herb Bog	G1, S1
	Wet Marl Forest	G1, S1
Vulnerable Riedwart Samuel Farret C2 S1		
	Piedmont Seepage Forest Interdune Pond	G2, S1 G3, S1
	Beech-Magnolia Hammock	G5?, S1?
	Piedmont Seepage	G2, S1
Rare	1 0	
	Upland Depression Swamp	G3, S1, S2
	Limestone Sink	G3, S1, S2
	Seepage Pocosin	G3, S1, S2
	Atlantic White Cedar Swamp Swale Pocosin	G2, S2 G2?, S2?
	Depression Meadow	G2:, S2: G3, S2
	Pine Savanna	G3, S2 G3, S2
	Pond Cypress Savanna	G3, S2
Uncommon		
	Barrier Island Pond Complex	G3
	Interior Freshwater Marsh	G3
	Longleaf Pine Savanna	G3
	High Elevation Seep Swamp Tupelo Pond	G3, S3 G3, S3
	Tidal Bald Cypress -	G3, S3 G3, S3
	Tupelo Gum Swamp	03, 53
	Tidal Freshwater Marsh	G3, S3
	High Pocosin	G3, G4
	Bay Forest	G3, G4, S3
	Pocosin	G3, G4, S3, S4
	Pond Pine Woodland	G4, G5, S3
	Natural Levee Acidic Cliff	G4, G4, S3, S4 G5, S3
	Intertidal Beach	G5, S3
	Pine Flatwoods	G5, S3, S4
	Bald Cypress Swamp	G4 G4
	Non-Riverine	G4
	Wet Hardwood Forest	
	Pond Cypress Pond	G4, S4
	Streamhead Pocosin	G4, S4
Comn		G4, S4
	Bald Cypress Tupelo Gum Swamp	04, 54
	Bottomland Hardwoods	G5, S4
	Non-Alluvial Swamp Forest	G5, S4, S5
	Atlantic Coastal Plain	G5
	Depression Meadow	
	Black Willow	G5
	Riverfront Forest	~ ~ ~
	Brackish Marsh	G5, S5
	Estuarine Intertidal Mud Flat Estuarine Intertidal Sand Flat	G5 G5
	Intertidal Mud/Sand Flat	G5, S5
	Nonriverine Swamp Forest	G5, S5 G5
	Salt Marsh	G5
	Small Stream Forest	G5, S5
	Upland Bog	G?, S?

VEGETATED COMMUNITIES (FROM NWI CODES)

A vegetated community index has been established following the examples provided by the Rookery Bay ADID project in Collier County, Florida, and the South Carolina Project in the Francis Beidler National Forest. These projects establish an indexed system of designating vegetative communities from NWI data sets that correlate well with the Nature Conservancy/Heritage Trust Rarity Ranking designation for habitats. Below are the general vegetated communities with the NWI code, number of occurrences, and rarity rank.

Wet Prairie (Depression Meadow)

PAB4Fh, PEM/SS1C, PEM/SS1F, PEM1/FO4A, PEM1/FO4C, PEM1/SS4A, PEM1/SS4C, PEM1/SS4Cd, PEM1A, PEM1Ad, PEM1As, PEM1Bd, PEM1Bd, PEM1Cd, PEM1Ch, PEM1Chs, PEM1Cx, PEM1F, PEM1Fb, PEM1Fd, PEM1Fh, PEM1Fhx, PEM1Fx, PEM1Gh, PEM1N, PEM1S, PFO1/SS3Ad, PFO1S, PFO4/EM1Ad Number of NWI Types: 30

Community Rarity Rank - Rare

Water

E1UBL, E1UBLX, E1UBLA, E1UBLX, L1UBHX, L1UBHA, L1UBHA, L2AB3Hh, L2AB4Fh, L2UBFh, L2UBHh, L2UBHx, L2UBT, L2USCHS, L2USCX, M1UBL, M2USN, M2USP, PAB3F, PAB3Fh, PAB3Fx, PAB3Hh, PAB3Hx, PAB4F, PAB4Hh, PAB4Hx, PUBF, PUBFh, PUBFx, PUBH, PUBHX, PUBHh, PUBHx, PUBHh, PUBHx, PUBKh, PUBKhx, PUBTh, PUBV, PUBVx, PUSAx, PUSC, PUSCX, PUSCh, PUSCx, R1UBV, R1UBVx, R1US2S, R2UBH, R2UBHx

Number of NWI Types: 49

Uplands

PFO1Gh, U

Number of NWI Types: 2

Swamp Forest (Riparian/Isolated Swamp Forests)

PEM/FO1C, PFO/SS1C, PFO/SS1Cd, PFO1/2C, PFO1/2Cd, PFO1/2Ch, PFO1/2F, PFO1/2Fd, PFO1/2Fh, PFO1/3T, PFO1/3B, PFO1/3Bd, PFO1/3Cd, PFO1/3Cd, PFO1/3Ch, PFO1/3R, PFO1/4A, PFO1/4Ad, PFO1/4B, PFO1/4Bd, PFO1/4Cd, PFO1/4Cd, PFO1/4Cx, PFO1/4F, PFO1/4S, PFO1A, PFO1AD, PFO1Ad, PFO1Ah, PFO1As, PFO1Ax, PFO1Cb, PFO1Cb, PFO1Cd, PFO1Ch, PFO1Cx, PFO1F, PFO1F, PFO1Fb, PFO1Fd, PFO1Fh, PFO1Fx, PFO1R, PFO1T, PFO2F, PFO3/1A, PFO3/1Ad, PFO3/1As, PFO3/1C, PFO3/1R, PFO3/4A, PFO3A, PFO3C, PFO3R, PFO4/3B, PFO4/SS1R, PFO6F, PFO6T, PFO7B, PFO7C, PSS/EM1F, PSS1/4C, PSS1/4Ch

Number of NWI Types: 64

Community Rarity Rank - Uncommon

Spoil Area

PSS1Adhs

Number of NWI Types: 1

Shrub Swamp (Bottomland Hardwood)

PFO/SS1R, PFO1/3As, PFO3Bh, PFO6/EM1F, PSS/EM1AD, PSS/FO1Cd, PSS1/2C, PSS1/2F, PSS1/2Fd, PSS1/2Fh, PSS1/2Gh, PSS1/2T, PSS1/3A, PSS1/3Ad, PSS1/3Bh, PSS1/3C, PSS1/3Cd, PSS1/3Cs, PSS1/3R, PSS1/3Ss, PSS1/4Ad, PSS1/4B, PSS1/EM1T, PSS1/FO1A, PSS1/FO4A, PSS1A, PSS1AD, PSS1Ad, PSS1Ah, PSS1Ahs, PSS1As, PSS1Bd, PSS1Bh, PSS1C, PSS1Cd, PSS1Ch, PSS1Gh, PSS1Sd, PSS1T, PSS2Fd, PSS4/EM1Cd, PSS4Ad, PSS6T

Number of NWI Types: 43

Community Rarity Rank - Common

Maritime Forest

E2FO4P, E2SS1P, E2SS1Pd, E2SS1Ps, E2SS3P, E2SS3R, E2SS4P, PFO4S, PSS1S, PSS4

Number of NWI Types: 10

Community Rarity Rank - Vulnerable

Low Hardwood Flat (Wet Hardwood Flat)

PSS1/3F, PSS3/1A, PSS3/1Bd, PSS3/1C, PSS3/1Fh, PSS3/1R, PSS3/1S, PSS3/FO1A, PSS3/FO1Ad, PSS3/FO1B, PSS3/FO1C, PSS3/FO1R, PSS3Ad, PSS3Ad, PSS3Ad, PSS3Bd, PSS3Cd, PSS3Cd, PSS3Ch, PSS3C

Number of NWI Types: 28

Community Rarity Rank - Uncommon

Hydric Pine Flatwoods (Longleaf Pine Flatwoods, Savannah, Saw Palmetto Flatwoods)

PFO/EM1Cd, PFO1B, PFO1Bd, PFO3/1B, PFO3B, PFO4/1A, PFO4/1Ad, PFO4/1B, PFO4/1C, PFO4/1R, PFO4/2Cd, PFO4/EM1A, PFO4/SS1A, PFO4/SS1B, PFO4/SS3B, PFO4A, PFO4Ad, PFO4Ah, PFO4B, PFO4Bd, PFO4Bh, PFO4Cd, PFO4Cd, PFO4Cd, PFO4Cx, PFO4Cx, PFO4R, PSS/FO4B, PSS1/3B, PSS1/4A, PSS1/4S, PSS1/FO4Cd, PSS1B, PSS4/1A, PSS4/1B, PSS4/EM1A, PSS4/EM1Ad, PSS4/EM1R, PSS4A, PSS4B, PSS4Bd, PSS4Cd, PSS4Cx, PSS4Cx, PSS4R, PSS6F

Number of NWI Types: 45

Community Rarity Rank - Uncommon to Rare

Freshwater Marsh (Tidal Freshwater Marsh)

L2EM1Hh, PEM/SS1A, PEM1/SS3C, PEM1Ah, PEM1CHS, PEM1R, PEM1Rd, PEM1Rh, PEM1Th, PFO1Rd

Number of NWI Types: 11

Community Rarity Rank - Uncommon

Cypress Swamp (Pond Cypress, Tidal Bald Cypress-Tupelo Gum Swamp)

PEM1/FO2C, PEM1/FO2F, PFO2/1C, PFO2/4C, PFO2/EM1F, PFO2C, PSS/FO1C, PSS1F, PSS1Fd, PSS1Fh, PSS1Fx

Number of NWI Types: 11

Community Rarity Rank - Uncommon

Coastal Salt Marsh

E2EM1M, E2EM1ND, E2EM1ND, E2EM1ND, E2EM1PD, E2EM1PD, E2EM1Pd, E2EM1Ph, E2EM1Ph, E2EM1Ps, E2US/EM1P, E2USM, E2USNs, E2USPs, E2USPd, E2USPs

Number of NWI Types: 17

Community Rarity Rank - Common

Bay Forest (Pond Pine, Pocosin, Oak-Hickory Forests)

PSS1R, PSS1RD

Number of NWI Types: 2

Community Rarity Rank - Uncommon to Rare

Not Listed(unverified)

E2EM1/USP, E2EM1Kh, E2EM1Nx, E2FO3P, E2FO4B, E2FO7P, PAB4Fx, PAB4H, PAB4Kh, PABGh, PABHx, PEM1/FO4B, PEM1/SS3B, PEM1Ax, PFO1/2A, PFO1/2B, PFO1/2Gh, PFO1/2R, PFO1/2Td, PFO1/3Ad, PFO1/3S, PFO1/SS3B, PFO1/SS4Ad, PFO1Bh, PFO1Kh, PFO1Sd, PFO2/IF, PFO2/EM1C, PFO2Fd, PFO2Fx, PFO3/4B, PFO3Ad, PFO3Bd, PFO4/1Bd, PFO4/1Cd, PFO4/1S, PFO6/AB4Gh, PFO6C, PFO6Cd, PFO6Fb, PFO6Fd, PFO6G, PFO6Gh, PSS1/2Cd, PSS1/3Bd, PSS1/3S, PSS1/4Bd, PSS1/FO2C, PSS1Tx, PSS4/1Ad, PSS4/1C, PSS4/EM1B, PSS4/EM1Bd, PSS4Ah, PSS7B, R2USA

Number of NWI Types: 56

APPENDIX E: REFERENCES

REFERENCES

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